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EFFECT OF THE METHOD OF CONCENTRATING QUARTZ FEEDSTOCK ON THE OPTICAL CHARACTERISTICS OF COLORED GLASS

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The effect of the method of concentrating quartz feedstock on the purity of colored glass was investigated. It was shown that concentration of Kozlovskoe quartz sand by flotation and chemical methods allowed reducing the total Fe_xO_y by 3 times and obtaining glass with spectral light transmission in the visible region of up to 84%. The color tone of the experimental glasses made from initial and concentrated sand was within the yellow region according to calculations of the chromaticity coordinates and corresponding structures in the color triangle.

The wide use of colored glass in modern design is due to its elevated consumer characteristics: transparency, hardness, chemical stability, ability to assume different expressive shapes, and rare color combinations [1]. One of the main indexes characterizing the external commercial appearance is the color of the glass, whose quantitative evaluation is measured by light transmission and the dominant wavelength in the visible part of the spectrum. These indexes in turn are a function of the content of coloring impurities in the glass (iron, chromium, titanium oxides, etc.), special additives to the batch (carbon, nitrates, sulfates, arsenic, cerium, antimony oxides, etc.), organic inclusions, and products of corrosion of current-conducting metallic materials (molybdenum, steel, etc.) in electromelting. To take into account the effect of impurities and small amounts of additives, the compositions of the raw materials, the redox characteristics of the raw materials and batches, the melting modes and conditions, and the possible chemical changes and reactions in the glass melt as a function of the melting conditions must be systematically monitored for their content. The necessity of such monitoring was demonstrated in [1 – 4].

The quality of the raw materials used and primarily the quartz sand is important for production of high-quality optical glass, crystal, glass for laser technology, glaze pigments of elevated whiteness and clarity of color of the glass. The complexity of purifying quartz sands consists of the fact that sands from different deposits have different chemical compositions, and the iron oxides in them are concentrated in different impurity minerals, both free and united with the quartz grain, in mineral impurities inside the grains, in mineral iron-containing film formations on the surface of the grains, and in structural impurities. For this reason, there has not been any universal method of treating silicate materials to remove coloring impurities up to now.

We investigated the effect of the method of concentration of quartz raw material on the purity of color of colored glass.

Yellow coloring ranging from light yellow to orange hues can be obtained with a combination of cerium and titanium oxides in the ratio of $CeO_2 : TiO_2 = (1 : 2) – (1 : 3)$. The glass compositions can be lime–silica or lead. The most intensive shades are obtained in potassium compositions. For this reason, an industrial composition for mechanized treatment of high-quality glass was selected for synthesis of yellow glass.

Kozlovskoe quartz sand PB-150-1, Melikhovo-Fedotovo dolomite, Belgorod chalk, boric acid, soda, sulfate, potash, and cerium and titanium oxides in the ratio of 1 : 2 were used as the raw materials for preparation of the batch.

TABLE 1

Fraction, mm	Weight content of quartz sand grains, %	
	before flotation	after flotation
0.80	0.65	0.50
0.65	8.82	9.08
0.50	16.89	15.86
0.25	45.41	49.40
0.08	26.32	23.19
< 0.08	1.91	1.97

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TABLE 2

Index	Quartz sand									
	initial		after mechanical rubbing		after flotation		after washing		after chemical concentration	
	sample 1	sample 2	sample 1	sample 2	sample 1	sample 2	sample 1	sample 2	sample 1	sample 2
Fe_xO_y content, %	0.38	0.36	0.17	0.16	0.11	0.12	0.21	0.23	0.09	0.10
Brand of sand	T		PS-250		PB-150-1		PS-250		B-100-2	

Concentration of quartz sand with a weight content (%) of: 97.80 SiO_2, 1.04 Al_2O_3, 0.14 CaO, 0.10 MgO, 0.60 Na_2O, 0.37 Fe_xO_y, 0.50 calcination loss, was conducted by mechanical rubbing, flotation, chemical concentration, and washing with water. The iron oxide content before and after concentration was determined chelatometrically as the most widespread, accessible, and efficient.

The batch was prepared according to the formulation using the initial unconcentrated quartz sand (Sample No. 1), sand after flotation (Sample No. 2), sand after mechanical rubbing (Sample No. 3), sand washed with water (Sample No. 4), and sand after chemical concentration (Sample No. 5).

The glass was melted in a laboratory electric furnace with 100 cm^3 alundum crucibles at 1400°C with holding of the melt at the maximum temperature for 1 h. The homogeneous glass melt was poured into metal molds. The samples were annealed in a SNOL-1 electric furnace for 1 h at a holding temperature 10°C below the glass transition temperature with subsequent natural cooling. The optical characteristics of the glass was determined with a SF-56 spectrophotometer and the purity of the color was determined by calculation.

Concentration of quartz sand by mechanical rubbing and flotation altered the granulometric composition: the content of 0.8 mm particles decreased by almost 1.5 times and the amount of powdered fraction doubled. The results of concentration of the quartz sand by flotation are reported in Table 1.

The data from determining the Fe_xO_y content (Table 2) indicate that the chemical and flotation methods are the most effective methods of concentrating silica feedstock, since the total content of iron oxides in the samples decreased by 3 times while spectral light transmission in the visible region increased to 84%.

The method of chemical concentration allowed obtaining quartz sand with a Fe_xO_y content under 0.1%. However, use of this method could be justified in production of optical and special kinds of glass.

Calculation of the chromaticity coordinates and corresponding plotting in the color triangle (see Fig. 1) showed that the color hue of the experimental samples of glass made from the initial and concentrated sand by different methods was within the yellow region. The purity of the color was within the limits of 0.76 to 0.86 as a function of the method of concentration in consideration of the fact that the color purity for cerium and titanium is 0.43 and 0.83, respectively.

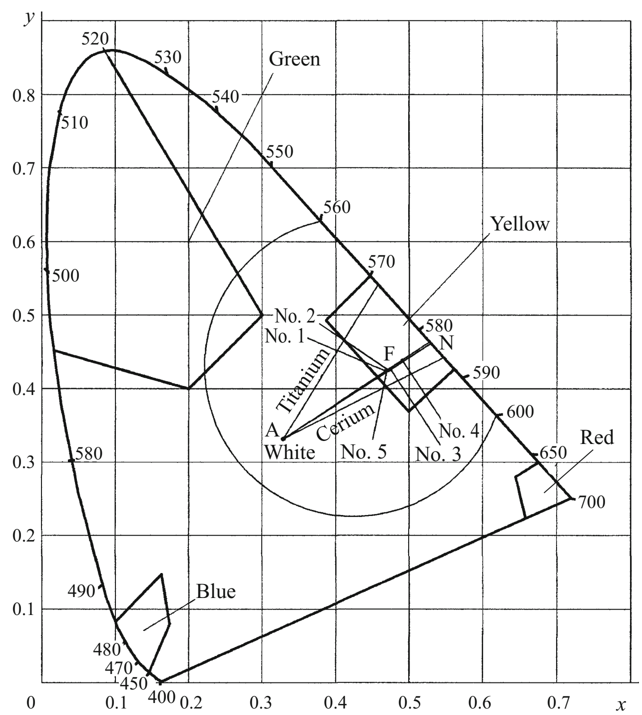

Fig. 1. Position of compositions of experimental samples of glass (Nos. 1 – 5) in color coordinates.

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